IEA/SolarPACES

Task I: Electric Power Systems

Task Meeting Summaries:

DLR/Köln, Köln, Germany	**14 October 96**
CNRS, Odeillo, France	**9-10 April 97**

Draft Program of Work: 1997-2000

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November 19, 2001

IEA/SolarPACES Task I Participants:

Since the last task meeting summaries published in April, 1996, we have had two IEA/SolarPACES Task I: Electric Power Systems task meetings: one at DLR in Köln on 14 October 96, and one at CNRS in Odeillo, France, on 9-10 April 97. Please find enclosed my summaries of these meetings. The table below provides a snapshot of Task I at this time, including all activities currently underway and changes made in coordination with the ExCo. Note that in addition to the two existing sectors, new Sectors 3. START Missions and 4. Market Barriers and Opportunities have been created to formalize these activities. Cooperative activities are those involving more than one country as active participants, while information-sharing activities are those where the participants have agreed to provide regular informational updates to the Task. I have also included with the meeting summaries, the current draft of our Task I Program of Work for 1997-2000 – thanks to all of you for your help in preparation. I presented our Task status to the ExCo in Brazil in May, including this Program of Work, and it was all well received.

Task I: Electric Power Systems (C. E. Tyner, Operating Agent)

Sector 1. Central Generation Systems (Geyer, Sector Leader)

Cooperative Activities:

- System Operations and Maintenance Cost Reduction (Cohen, KJC)
- Direct Steam Generation System Evaluation(Meinecke, DLR)

Information-Sharing Activities:

- Solar Two (Sandia, U. S. utility)
- Phoebus-TSA (Phoebus consortium)
- The DISS Project (Zarza, PSA)
- Solar Fields for DSG (Lippke, ZSW)
- Solar Thermal Activities in Israel (Epstein, WIS)
- THESEUS Project (Pilkington)

Sector 2. Distributed Generation Systems (Mancini, Sector Leader)

Cooperative Activities:

- Dish/Brayton Project (Sandia, NREC, DLR)
- Dish/Engine Compendium (Stine, Cal Poly)
- Tennant Creek and Big Dish Scale Up Studies (Stein, Pacific Power)
- Review of the Kislovodsk Solar Power Plant Study (Mancini, Sandia)
- Stirling Engine Exchange Program (Mancini, Sandia; Geyer, PSA)

Information-Sharing Activities:

- SAIC Utility-Scale Joint Venture Program (SAIC)
- Dish Engine Critical Components Project (Mancini, Sandia)
- SBP Dish/Stirling Project(Schiel, SBP)

Sector 3. START Missions (Geyer, Sector Leader)

Sector 4. Market Barriers and Opportunities (Williams, Sector Leader)

Thanks for your active participation in Task I activities and for helping expand our areas of cooperation.

Sincerely,

Craig E. Tyner
Operating Agent, Task I

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IEA/SolarPACES Task I Meeting:
Solar Thermal Electric Power Systems

14 October 1996
DLR/Köln, Köln, Germany

Meeting Summary

An IEA/SolarPACES Task I Meeting on Solar Thermal Electric Power Systems was held in conjunction with the 8th International Symposium on Solar Thermal Concentrating Technologies and Task II and Task III meetings at the DLR Facilities in Köln, Germany, on 14 October 1996. In addition to reviewing most of the ongoing joint activities in Task I, a major new activity to assess and address non-technical issues affecting implementation of solar thermal technologies was identified (based on action at the ExCo meeting) and planned. An updated meeting agenda, attendees' list, and presentation summaries are attached.

Detailed Meeting Minutes

The Task I meeting was chaired by Craig Tyner, as Operating Agent for Task I. After agreement on minor changes to the proposed Task I agenda (attached, as corrected), reports of ongoing Task I activities were presented, followed by a discussion of activities cutting across the two Sectors. Presentations were generally limited to those items not covered in detail at the conference.

Sector 1. Central Generation Systems

Status Updates were led by Sector Leader Michael Geyer of DLR/PSA.

O&M Cost Reduction Study at KJC (Gilbert Cohen, KJC): Approximately a 30% reduction in O&M costs has been achieved. The program will be completed in March but activities will continue. The status of the plants' revenue stream changes this next year, so additional cost reductions will be required. They will continue with ball joint replacements; there is a new selective coating for the receiver tubes and they may not use a vacuum on the new configurations (a significant reduction in cost); and they will improve mirrors with a stronger facet that will allow them to track in higher winds. They have also tested a high pressure, rotating spray washer that gives results equivalent to those found with contact brushes.

Direct Steam Generation (Wesley Stein, Australia): Current status of the Australian large dish was presented. The dish is 400 m^2 and produces about 320 kW_t of 500 C and 5.5 MPa steam. It currently has 2000 hours of unattended tracking hours running a steam engine. Because of the poor reflective quality of the mirrors and alignment of the dish, the efficiency is only 67%. The dish was designed for low concentration and not to cant or adjust the facets. A counter-flow rotary joint of their own design was implemented for water/steam transport to/from the receiver and has demonstrated good performance to this time.

DISS (Eduardo Zarza): They are currently implementing a test loop at the PSA; the field configuration has been revised to utilize two parallel rows with steam generators and super heaters separated in the field. The superheat feeds the nine steam injectors along the receivers as well as providing steam for power generation. They use only one pump for the system. Three DSG concepts have been identified for evaluation at the test facility. High-pressure ball joints are critical to the design and a separate test rig

has been developed to evaluate the ball joints. The 550-meter long system will be installed at the PSA this next year, with installation in June 1997 and initial test and acceptance late in 1997.

DSG applied Research: At PSA they have optimized the injection process, defined test equipment for evaluation of the collector, and defined interfaces for control and test. A special test collector will be installed as the first one in the super heat section -- to evaluate the flow patterns in two-phase flow through tilting at 2-degree increments.

Collector Improvement: They are currently implementing a test loop at PSA for evaluating new designs including mirrors, control, and an innovative, light-weight trough design that is currently underway using a stretched membrane concept.

Solar Two Update (Greg Kolb, SunLab): Results were presented at the conference. The plant is not currently operating daily -- there are only 50 hours of operation on the receiver. The receiver design is robust in that we have abused it and it continues to operate. Heat trace has been a major problem with the plant. The problems with the heat trace were due to poor installation and inadequate inspection of the installation. Also, a new system would probably use stainless steel throughout the plant instead of a mixture of low-carbon and stainless steel.

PHOEBUS/TSA (Gary Weinrebe, DLR/ED-PSA): Next steps for the TSA facility include operation as a plant next year by connecting to the CESA 1 turbine for operational training and replacing some absorber materials (about 5% of the plates) in the receiver for comparative testing of volumetric receiver materials for a simpler, less costly design. In the new absorbers, throttling will be done in a single stage using a perforated plate to avoid an unstable flow pattern. How will the risks of scaling to a 40 MW electric plant and about a 120 MW_t receiver be accommodated? Steinmüller will warrant it. The modularity of the receiver seems to be very important in this regard.

Israeli Activities (Avi Kribus, WIS): Kribus reported three separate programs with some overlap of subject matter and participants.

Israeli Only Program: This program is to support the development of technologies and capabilities. Ormat, Silver Arrow, WIS, Rotem, MLM Division of Israeli Aircraft, Ben Gurion University, and Tel Aviv University are developing a high temperature receiver with a tower-mounted reflector and CPCs located at the base of the tower providing input to an Ormat turbine.

Israeli Aircraft is developing satellite substitutes for long-term operation using 200-500 concentration PV. Silver Arrow Aircraft also want a long-term platform for aircraft for military purposes. They are developing a solar thermal helicopter with a dish/receiver and a Wankel engine. It will hover at 70,000 ft. for several months. They would also propose a dish in a bubble to generate electric power.

The Second Framework US/Israeli Bi-national agreement includes McDonnell-Douglas, WIS, Ormat, and Rotem. They are developing a solar gas turbine operating at about 250 kW. The schedule for this plant includes operation at the Weizmann Institute in about four years.

The final project is the Dead Sea Works: It includes feasibility studies for melting of potash, power production from PV, cracking of LPG, and reforming. Results were that these schemes have different economics -- the most promising is LPG cracking. The study is currently being evaluated by the owners of the plants.

Colón-Solar Project (Manuel Blanco, CIEMAT, PSA): Blanco presented an update on the status for CIEMAT and Sevillana Elektra, who is the leader of the project. ENDESSA and Electicidad de Portugal received 1.2 million ECU's from the European Community. The Consortium was formed officially on October 10. The aim of the project is to complement a conventional power plant with a tower and a gas turbine. They are also trying to get solar electricity priced at 11 - 12 pts (normal price is about 5 pts.) per kWh. The consortium is made of suppliers of equipment and the utilities. The aim of the consortium is

to take a long-term view in developing technology as well as undertaking the project. The net effect is to upgrade the capacity of an existing plant by adding a topping cycle. Suppliers include Babcock and Wilcox for the conventional plant upgrade and ABENGOA for the heliostats. Total eligible costs are 7,000 million pts, with 1,000 million pts from European Union.

THESEUS (Michael Geyer): No additional information beyond that presented at the Conference was discussed. A 50 MW SEGS plant in Crete is planned, with a 50% solar share and back up from diesel #2. Storage has also been considered.

Training Program for Researchers: To promote training for solar thermal systems and to encourage European participation, the EU funds this work at the PSA for member nations of the EU. Applications should be submitted to the PSA attention of Mr. Martinez, by October 25, 1996.

Sector 2: Distributed Generation Systems

Status Updates were led by Sector Leader Tom Mancini, Sandia.

Dish-Brayton Project (Mancini, Sandia): This project involves the DLR, NREC, and Sandia. Project progress was impacted seriously by NREC's not delivering an engine to Sandia and by Cummins' leaving the solar program. Sandia intends to follow-up with testing of the receiver, but it is not clear just exactly what we will do at this time. Our options include continuing with NREC, possibly putting the receiver on another engine, and testing the receiver separately. Wes Stein stated that Australia is definitely interested in a Brayton for an Australian dish, and it may be possible to involve them somehow in a test program. SolarGen is also interest in an NREC engine for their systems.

Dish/Engine Compendium (Mancini for Bill Stine, Cal Poly): There was strong agreement that the document was very valuable. The next version will be delayed one year to include SBP, other solar engines, and recent test results. This version of the report will also include performance evaluation guidelines, which will be available for review and comment by SolarPACES prior to publication.

Review of the KSPP Project (Mancini, Sandia): The Kislovodsk Solar Power Plant report was prepared through the INTAS Program and a SolarPACES review team (including PV expertise) was assembled and the review initiated. The review comments are now being compiled and a report will be assembled for the reviewers by November. The summary report will then be presented to SolarPACES and Astrophysica including a discussion of the next reasonable step for the project.

Proposed Stirling Engine Exchange (Tom Mancini, Sandia): The main purposes are to expand the engine test database and to expose potential users to other available technologies. Since the engines (Solo Kleinmotoren and STM) are in different size ranges, they may not compete directly. Options for testing complete systems (in Australia, for instance) would significantly enhance this effort and are also under consideration.

Lastly, Mancini summarized the status of the current U. S. work in dish/Stirling including the Cummins Power Generation's leaving the solar business and the status of the SAIC Utility-Scale Joint-Venture Project, which is near restarting (started October 21, 1996).

Tennant Creek and Large-Dish Scale-Up Studies (Wes Stein): At the end of our meeting Wes provided a preliminary report that includes the Feasibility Study, the Scale-Up Study, and the Preliminary Testing Report. IPPs are starting to compete with the four power producers in Australia. A window of opportunity exists in the next five to ten years for the renewable technology to establish its position. Their approach involves selling steam provided from dishes. Long term they would anticipate developing thermochemical and/or Brayton technology for use with the dish whose costs have been reduced.

The ANU Big Dish: The economics of the Big Dish indicated by the Tennant Creek Study are about 13 to 19 AUS$/GJ (compared with current costs of about 3 - 4 AUS$/GJ) The scale up study showed that the equivalent cost of fuel in the 5 - 9 AUS$/GJ for only a fuel value, not a capacity value. Wes suggested this costing approach for comparing the different technologies.

Two major issues were identified in the report. Heat losses were greater than they anticipated. The stability of having a number of parallel steam generators is also an issue.

Comments from Stephan Kaneff on the last Task I meeting minutes were presented by Craig Tyner. Wes Stein indicated that Stephen's input would be coordinated in the future.

The Australians are also working on a Fresnel linear focus solar thermal concentrators. David Mills is quoting very low costs for the system.

SBP Systems (Michael Geyer, DLR/PSA): The new dishes are behind schedule because of failed membrane seams. The welding process was changed when they went to the laser welding approach. The next 100 dishes will be between 14,000 (660DM/m^2) and 7,400 (370DM/m^2) DM per kW installed.

DM/m^2	DM/kW installed	Units/year
1590	36,100	3
660	13,900	
370	7,400	1,000
260	4,700	
190	3,200	10,000

Cross-Cutting Activities:

Hybrid Systems Options (Klaus Hennecke, DLR - Köln): A brochure is currently being developed by Klaus for categorizing systems. The standard guideline was explained in the minutes of the last meeting. He has only received 3 examples for his brochure. Please send him more input. Also, there is a spreadsheet for the brochure. The analysis of hybrid options will be a Task 3 item, and the discussion of specific hybrid system performance will be a Task I issue.

For participation in a Hybrid Workshop, the following people volunteered to help: Michael Geyer, Dave Kearney, Greg Kolb, Avi Kribus, Franz Trieb, Reiner Buck, Klaus Hennecke, Tom Williams, Xavier Garcia Casals.

START Team Discussions (Michael Geyer, DLR/PSA): Discussion centered around how to get involved in START (Solar Thermal Analysis, Review, and Training) Teams and background information relative to the Egyptian approach and the support provided to Egypt through the Executive Committee. The Team met in February in Egypt and the draft report was provided to the Review Team and to Egypt. Comments will be incorporated and a final report prepared and distributed.

There have been requests from Jordan, Brazil, Zimbabwe, and South Africa for a mission. Jordan and Brazil are the two highest priority selections for START missions. Jordan has had a long-time interest in solar thermal initially related to the PHOEBUS project. The Jordanians are interested in building a plant. Brazil has asked for help organizing a solar thermal R&D Program.

It may be difficult to do more than two missions per year because of lack of funding. The World Bank may be able to support START missions. Another suggestion is that the SolarPACES members could provide additional support for the participation of START Team members.

Michael Geyer will prepare a brochure on what the START Team is, what the procedures are, and a form for potential START Team members. Those interested in participating should provide information to Michael Geyer.

Non-Technical Issues (Tom Williams, NREL): There is a historical precedent for this in the requests of a number of people over that last five years. There was some discussion on whether or not we should be involved in these activities:

- Is this within SolarPACES' charter?
- These activities are not mainstream with the capabilities of our group.
- If we need to do it, we need to get the "right" people involved.
- Forming a working group to list barriers and how we might proceed is the focus of today's meeting.
- The Pilkington report summarizes many of the issues of concern to this topic.
- Could the IEA become a worldwide political lobbying group? ExCo felt that it was the responsibility of SolarPACES to go no further than the preparation of materials that may be used by those who can lobby.
- Objectives: create incentives for near term that are self-serving and will allow us to get some systems out there; long-term objectives are equity in the tax and environmental sense.
- What has been covered so far? Get everything that has been done and compile it.
- The environment is rapidly changing and we need to keep track of how those changes affect things.
- Information clearing house on the status of planned/existing projects.
- How many support this as a Task Activity -- Should SolarPACES be involved in non-technical issues? 21 FOR and 1 AGAINST.

Craig Tyner, Dave Kearney, Greg Kolb, Franz Trieb, Irv Spiewak, Bernhard Milo, and Tom Williams, will form a working group in this area. It was suggested that we have information from the working group in advance of the meeting at the beginning of 1/2 day prior to the next Task I meeting.

Update on Mexico (Jorge Huacuz): He is on a mission to evaluate the issues of the Mexican government and their potential involvement in SolarPACES. They are working on solar ponds and believe that they are appropriate for their country. In the 1980s, they had a group of people involved in evaluating the concentrating technologies. They were involved with a number of technologies and monitored a number of the ongoing experiments throughout the world, including impacts on different industries within Mexico. In the late 1980s, the Mexican government lost interest in renewables and work was reduced to a series of academic studies.

The insolation of areas in northwestern and southeastern Mexico is very supportive of solar energy technologies. In addition there are opportunities for load matching due to peaking of demand on both a daily and seasonal basis. The legal framework for IPPs to work within Mexico was established several years ago and negotiations started with LUZ but nothing came of these discussions.

More recently, market studies have been done with SAIC and CPG for dish/Stirling systems. The focus of these studies was the non-technical issues, especially the infrastructure for continued support of the system and for O&M. When they took the people from CPG into Mexico, he felt that they were discouraged by what they saw for potential infrastructure support. They have a large PV program. Mexico asks the question of who will create the infrastructure for support of the technology? *Jorge*

Huacuz said advances of technologies must go hand-in-hand with other issues, i.e., the support infrastructure.

They are also considering a project for an ISCCS plant. They are looking at many other technologies and receiving a lot of pressure from vendors, thus, their interest in SolarPACES.

Task I Meeting Action Items (all designated 9610-#):

1. Parties interested in participating in the Training Program at the PSA should contact Senior Martinez at the PSA before October 25, 1996.
2. The Summary of the Tennant Creek and Large-Dish Scale-Up Studies will be distributed to SolarPACES members. [Wesley Stein, working with Tyner on procedure]
3. The Hybrid Workshop will be developed following assembly of pertinent information to ask utility and other decision makers for their input on their critical issues. [Michael Geyer]
4. The Report Summarizing the Solar PACES Task Force review of the Kislovodsk Solar Power Plant will be distributed by February 1997. [Tom Mancini]
5. START Team process and procedures to be developed. [Michael Geyer, Wilfried Grasse]
6. Information Questions to be asked of potential START Team host countries will be developed. [Michael Geyer]
7. A one-page description of what a START Team is will be developed. [Michael Geyer]
8. The "Other Issues" Working Group will assemble information and provide it to Task I participants prior to the next Task I meeting. A 1/2-day working group meeting will be conducted the day prior to the next Task I meeting. [Tom Williams]
9. If possible, technical details on the Colón-Solar project will be provided to Task I participants. [Manuel Blanco]
10. Request input for Task I for Plan of Work, with details for first year or two and generalities for out-years Ask for planned achievements and over-arching objectives. Provide additional time at next meeting (with advanced material) for discussion and approval of plans (Input by 1 Dec). [Craig Tyner]

Appendix A: Meeting Agenda

IEA/SolarPACES Task I: Electric Power Systems

Task I Meeting

DLR/Köln
Köln, Germany
Monday, October 14, 1996

Agenda

8:30 am	**Sector 1: Status Updates**	**Geyer**
	O&M Cost Reduction	Cohen/Kearney/Kolb
	Direct Steam Generation	Stein
	Solar Two	Kolb
	PHOEBUS/TSA	Weinrebe
	• Next Steps with the TSA System at the PSA	
	DISS	Zarza
	• Technical Progress of the DISS Project since Jan 1	
	Israeli Industrial Activities	Kribus
	• Advanced Concentrating Solar Technologies (PV, Brayton, Storage)	
	• Status of the Dead Sea Works Proposal	
	Colón-Solar	Blanco
	• Next Technical Steps of the Colón-Solar Project	
	THESEUS	Pilkington?
10:30 am	**Sector 2: Status Updates**	**Mancini**
	Dish Brayton Update	Mancini
	Dish/Engine Compendium	Mancini for Stine
	Tennant Creek and Scale-Up Study Update	Stein
	Kislovdskaya Review	Mancini
	Stirling Engine Exchange	Mancini/Geyer/Meike
	Cummins, SAIC, and Potential New USJVP Status	Mancini
	SBP Development	Schiel
12:30 pm	**Lunch**	
1:30 pm	**Cross Cutting Activities**	**Tyner**
	START Team Status	Grasse, Geyer
	• UK mission	
	• Other opportunities: Brazil, Jordan, South Africa	
	• World Bank	
	Hybrid Systems	Hennecke, Geyer
	• Organization for Specific Projects	
	• Feedback from Conference Workshop	
	Non-Technical Issues	Tyner, Kesselring, Geyer
	• Addressing Environmental Issues	
	• Financing	
	Options for a new Sector and/or a new Task	Tyner, Kesselring
4:30 pm	**Other New Business and Action Items**	**All**
5:00 pm	**Adjourn**	

Appendix B: Meeting Participants

Appendix B: Meeting Participants (cont.)

Appendix C: Notes from the Hybrid Workshop.

The Hybrid Workshop at the 8th International Symposium on Solar Thermal Concentrating Technologies was organized and chaired by Craig Tyner. It was based on a set of questions intended to provoke interest and comments from the participants. The final summary of the workshop, presented on the last day of the conference, is reproduced below because of its relevance to Task I activities.

Hybrid Workshop Summary:

The workshop was structured in a series of questions in which panel members would pose critical issues and moderate audience responses to those questions. The purpose was primarily to explore opinions and elicit discussion on hybrid solar electric power generation using a combination of solar input and fossil fuel.

What are the advantages and disadvantages of hybrid systems?

The focus of work to date in this area has been on gas-fired combined cycles. The initial motivation for integrating solar energy into these systems is to take advantage of their high thermal efficiency. Initial work has concentrated on introduction of solar into the bottoming cycle, while recent work has moved towards the possibility of higher temperature solar energy being utilized in the topping cycle. Introduction into the bottoming cycle has resulted in relatively low solar fractions, which has been raised as a concern. Integration in systems such as steam Rankine cycles, on the other hand, results in a very high solar share.

- We need to demonstrate that solar systems work and are reliable, and that the introduction into conventional systems should focus on the simpler integration approaches rather than more complex systems like hybrid approaches such as combined cycles. Repowering of conventional systems is one of example of such an opportunity.
- An early impetus leading to hybridization has been the need to use solar in high capacity factor systems in which fossil energy is used at high efficiencies.
- While it is easiest to integrate into the bottoming cycle, the topping cycle offers a better thermodynamic efficiency.
- If we are driven to very low solar fractions to become economic, perhaps hybrid solar systems are not ready to enter the marketplace without further development.
- In the long term, options that utilize higher temperature cycles, with higher efficiency, may offer the most cost-effective hybridization. Examples are topping cycles and regenerative Brayton cycles.
- With regard to the introduction of solar with small solar fractions, there is some concern that such use may in fact disrupt the operation of the conventional plant, resulting in poor performance. This issue needs clarification.

Why ruin a perfectly good fossil-fueled plant with solar, or visa-versa?

This question had its birth in a recent workshop in the U.S. which included participants from many different sectors - the solar industry, R&D institutes, conventional power equipment developers and utilities.

- Hybrid solar systems can lead to off-design operation in the power block, lowering efficiencies compared to pure fossil-fueled operation.
- The solar industry has to prove to conventional power system users and developers that solar is advantageous.

- One option for higher efficiency hybrid systems is to utilize solar energy for synthetic fuel generation or coal gasification.
- An approach which should be used for the integration of solar is to identify important niche markets, emphasizing small applications, rather than move quickly to large, conventional power systems.
- It is important to reduce the risks of introducing solar in other ways as well. For example, if the solar fraction is held to less than, say, 20%, the financial risk can be held within acceptable bounds. By adjusting the solar fraction to acceptable levels, the risks to users and financial institutions may be limited to feasible levels.
- The GEF and World Bank considerations are being driven by global warming issues, i.e., the global need to reduce CO2 emissions. Strong interest has been shown towards the use of currently proven solar thermal technology for near-term applications as part of the technology mix to help achieve these goals.

How do we evaluate and market hybrid options?

Do we evaluate them on the basis of lowest capital cost, lowest electricity cost, lowest solar-specific costs or the lowest avoided CO2 emissions cost?

- The user who will define the selection criteria, not the solar industry or the developer. Users and policy makers might include the GEF, World Bank, CSTRR in Nevada, bilateral funding banks, and in-country energy agencies. Markets are not homogenous - there are many different criteria that users apply. Because there have been such variations in the criteria applied to date by analysts, there has been confusion created in the community.
- In evaluating the value of solar energy to reduce global warming, should we also compare the CO2 avoidance cost against other renewables and non-solar methods of removing CO2.
- The point has been made by some that the solar community should not enter this marketplace until more advanced, higher efficiency systems are available. But other industrial sectors pragmatically enter the marketplace with products whose designs are evolving - why should the solar thermal industry be any different?
- Some confusion may be created by differing methods of presenting results. It may be valuable to standardize formats of presentation and modeling assumptions for base-case comparisons.

Where do we go from here? As a utility, why would I want to use a solar thermal system?

- Utilities can reduce risk on future fuel prices by investing in renewables.
- In the restructuring of the utility industry, some utilities are being asked by their regulators to take the perspective of providing a broader social value to their customers.
- Solar thermal and other renewables are forward-looking technologies with respect to fuel diversity and environmental issues which utilities would be well served to consider in order to ensure a stronger competitive position in the future.
- Niche markets or green power markets will be an important entry for our technologies.
- We seem to be talking about solar energy applications for their own sake, whereas the reduction of CO2 emissions is the only real driver.
- In order to bring more clarity to analyses, a workshop could be held to compare modeling techniques and tools.

SUMMARY

Standardization of analyses, models and assumptions could provide more clarity to comparison of different technologies and systems

The reduction of CO2 emissions is one of the most important major near-term drivers for the introduction of solar thermal electric technologies.

Near-term systems tend to emphasize solar integration in bottoming cycles, whereas the best thermodynamic efficiency will be realized by higher temperature integration in the topping cycles.

Issues surrounding the degree of hybridization, i.e., the solar share, remain a controversial topic within our own community.

Appendix D: Presentation Summaries

IEA/SolarPACES Task I Distribution